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CIRCULAR No. 396 JULY 1936
UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

A METHOD OF HARVESTING GRAPEFRUIT TO RETARD STEM-END ROT

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INTRODUCTION

The idea of pulling grapefruit instead of clipping it may seem radical to those not steeped in citrus lore or to those whose memory does not go far back of the big freezes of 1893–94. Before specially constructed fruit clippers became generally used it was a common practice to pull citrus fruit; so to old-timers this idea is not new but rather revived, whereas to younger horticulturists it may seem like a wide departure from crop-tested and time-approved procedure. However, there is a sound reason for pulling such Florida citrus fruits as lend themselves to this method of harvesting.

Although citrus fruits are not indigenous to Florida, there are a number of wild groves that presumably have resulted from the scattering of seed by animals into genial shaded hammocks long before these places were explored. In such locations conditions often favor the development of a wide range of plant diseases, including some that cause decay of the fruit.

STEM-END ROTS IN CITRUS FRUITS

In Florida citrus fruits are subject to several kinds of decay, by far the most destructive of these being the stem-end rots, which are identical in appearance. Stem-end rot is caused by either of two fungi, *Diplodia natalensis* Evans and *Phomopsis citri* Fawcett, which differ considerably in appearance but are similar in other respects, particularly in general behavior. The significant practical difference is that one develops at a lower temperature than the other. In many cases both organisms may be recovered from the same fruit. The fungi producing stem-end rot grow in dead twigs, and from them spores fall onto fruit and fruit stems below. It is probable that before the fruit is harvested the stem or its parts become

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infected and the decay organisms, incapable of vigorously attacking active tissue, remain in a quiescent state, only rarely invading the fruit proper while it is attached to the tree. However, after the fruit is clipped, infection in the stem parts advances into the fruit. The time required for the organisms to enter the fruit and produce decay depends on maturity, temperature, and other factors. Under extreme conditions the decay occurs within a few days, but ordinarily it does not develop seriously within less than a week after the fruit is harvested. Therefore, if fruit with infected stems is pulled, the point of infection may be separated from the fruit, thus preventing development of decay. Exceptions to this general rule are as follows: (1) When the fruit is dead ripe and ready to fall from the tree the fruit-bearing twig as well as the fruit is in a senile condition and the rot fungi may already have advanced into the fruit; and (2) when the tree is in a weakened condition due to unbalanced water supply, to parasites, or to hunger, the fruit-bearing twigs also are weakened and in many instances rot organisms may have entered the fruit before it drops.

STUDIES ON HARVESTING METHODS

Working on the hypothesis stated above regarding the behavior of the disease, investigators started tests several years ago to determine whether it would be practical to pull Florida citrus fruits without injuring the rind. It was soon determined that the rind of tangerines tears too easily in this procedure. Oranges can be successfully pulled only when the fruit is fully ripe; this was a common practice before the day of fruit clippers. However, it was found that grapefruit can be pulled at almost any time during the normal marketing period with little injury to the rind or no more than usually occurs when the fruit is clipped. Even with inexperienced pickers, the tearing of the grapefruit rind at the stem (commonly referred to as "plugging") occurred in only a small proportion of cases. Most of the lesions resulting were inconspicuous and were rendered harmless by the borax dip usually given the fruit when it reached the packing house. Moreover, the lesions were less abundant than clipper cuts and stem bruises in fruit clipped in the usual way.

STORAGE TESTS

At intervals covering several years, tests were made to determine the keeping quality of pulled as compared with clipped grapefruit, all other conditions being identical. Both seedy and seedless grapefruit in an advanced (dead ripe) stage of maturity, as well as some harvested at an early stage of legal maturity, were used in the tests. Some lots were treated with borax, while companion lots were not so treated. In several packing houses some lots of fruit were placed in storage rooms without receiving the usual packing-house treatments, while others were commercially washed, waxed, and packed in the regular manner. In some experiments the fruit was held at 70° F.; other lots were held at 60°, 55°, 50°, and 34° to 36°, in order to subject the test lots to the wide range of temperatures often encountered in marketing the crop.

CLIPPING VERSUS PULLING GRAPEFRUIT

The composite results of three seasons' work with clipped and pulled grapefruit held at 70° F. are shown in figure 1. Although this figure includes the total decay of all types, the stem-end rot fungi were responsible for practically all of it. The fruit was picked at various stages of maturity beginning soon after it reached legal maturity, but none of it dead ripe. Some of the lots were subjected to the ethylene degreening treatment prior to storage, but none of them was given the customary washing and polishing which is a part of commercial packing operations. Figure 1 shows not only that pulled grapefruit decays less rapidly than clipped grapefruit but that the use of borax still further reduces decay.

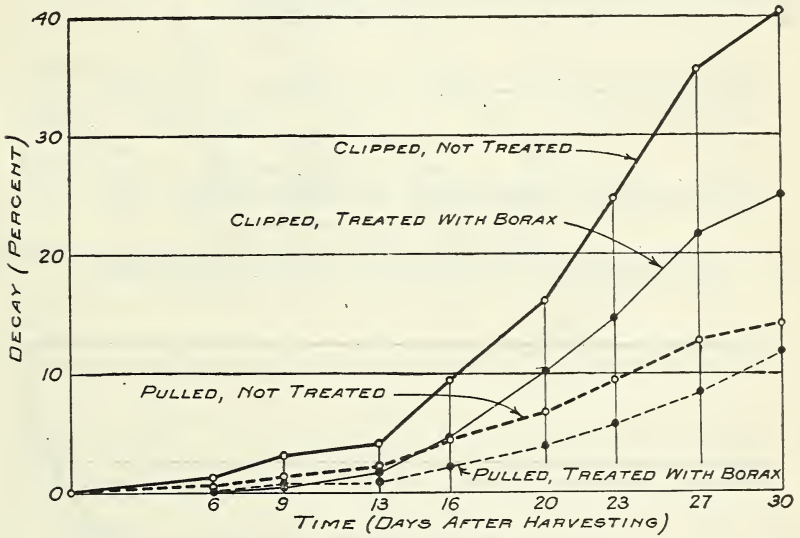

FIGURE 1.—Average decay of grapefruit harvested by clipping or by pulling and held at 70° F. during seasons of 1931–32, 1932–33, and 1934–35.

Figure 2 shows the rate of decay in clipped and in pulled grapefruit harvested at various times during the season of 1934–35, starting as soon as the fruit was well past the minimum requirements for legal maturity, including some frost-damaged fruit, and all treated with borax and stored at different temperatures. In these tests, again, pulled grapefruit decayed less rapidly than clipped fruit at each temperature. Figure 2 also shows the influence of lowered temperatures on the development of decay.

Figure 3 shows the rate of decay in clipped and in pulled grapefruit held at 55° F. during the spring of 1932. This fruit was produced in groves that had been in a run-down condition for several years and generally was of poor keeping quality. It was given regular packing-house treatment. As shown in figure 3, pulled fruit decayed less rapidly than clipped fruit, and fruit treated with borax kept better than untreated fruit. This indicates that pulled fruit given the borax treatment has a much longer life expectancy than clipped fruit not given the treatment.

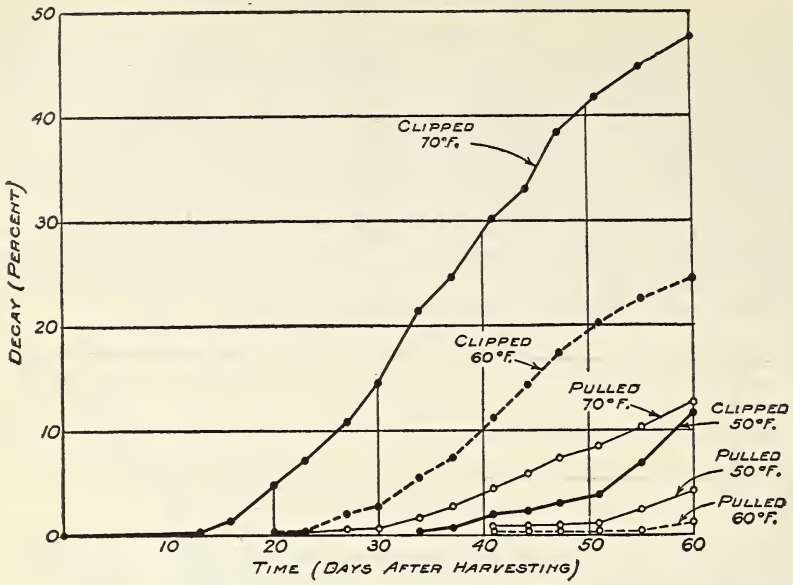

FIGURE 2.—Average decay of grapefruit harvested by clipping or by pulling, treated with borax, and held at 50°, 60°, and 70° F. during the season of 1934–35.

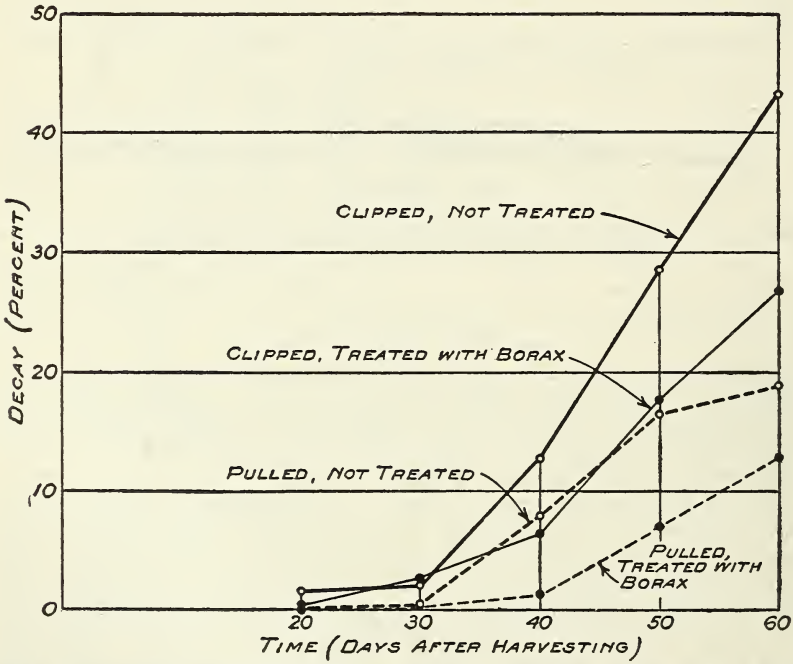

FIGURE 3.—Average decay of grapefruit harvested by clipping or by pulling and held at 55° F. during the season of 1931–32.

INFLUENCE OF MATURITY ON RATE OF DECAY

Figure 4 shows the rate of decay in commercially packed grapefruit that was produced in an old grove and was dead ripe when harvested. This fruit was stored for 46 days at 34° to 36° F. and then transferred to a 70° room, where it was examined periodically for a month. The rates of decay for the different lots indicate that the stem-end rot fungi had advanced from the stem or stem parts into the fruit before harvest, as the pulled fruit decayed at essentially the same rate as did the clipped fruit. Similarly treated lots from the same grove, picked and packed at the same time and stored at 55° for the same length of time before being transferred to the

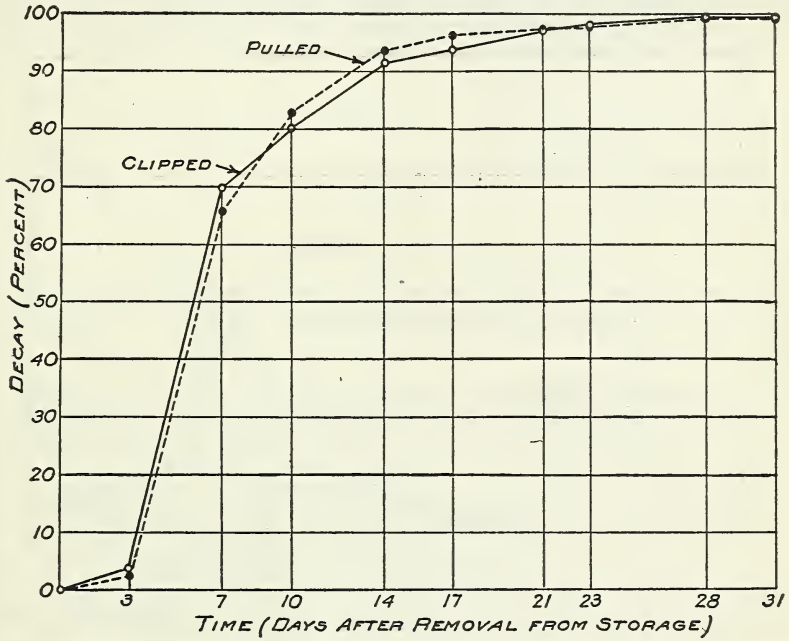

FIGURE 4.—Average decay of dead-ripe grapefruit harvested by clipping or by pulling, stored 46 days at 34° to 36° F., and held at 70° during the season of 1932–33.

70° room, decayed even more rapidly. This indicates, contrary to what some people affirm, that a low storage temperature is not a prime factor in inducing an excessive rate of decay after removal from storage.

Further evidence that dead-ripe citrus fruit without stem buttons decays about as rapidly as does similar fruit with stem buttons adhering is being reserved for later publication. The evidence is strong that the pulling of dead-ripe grapefruit cannot be relied upon to control stem-end rot, but that when the fruit is less senile, pulling is effective. When the fruit is pulled at full maturity the borax treatment also fails to retard decay.

INFLUENCE OF ADHERING STEM PARTS ON INCIDENCE OF DECAY

When fruit is pulled the entire stem, including the stem cushion, is not always removed. It is desirable, therefore, to examine the

data obtained when pulled fruit was divided into three classes with respect to the amount of stem parts adhering, and to compare the keeping quality of such fruit.

Figure 5 shows the relation of keeping quality to the amount of stem parts adhering to common or seedy grapefruit stored at 70° F. These are composite data from several collections, the earliest of which was made as the fruit reached legal maturity in the fall of 1934, three collections being made thereafter at monthly intervals. The fruit was grown in a grove that generally produced fruit of poor keeping quality. The first two collections were given the ethylene degreening treatment. One-half of each lot was given the borax treatment, while from the other half the antiseptic bath was

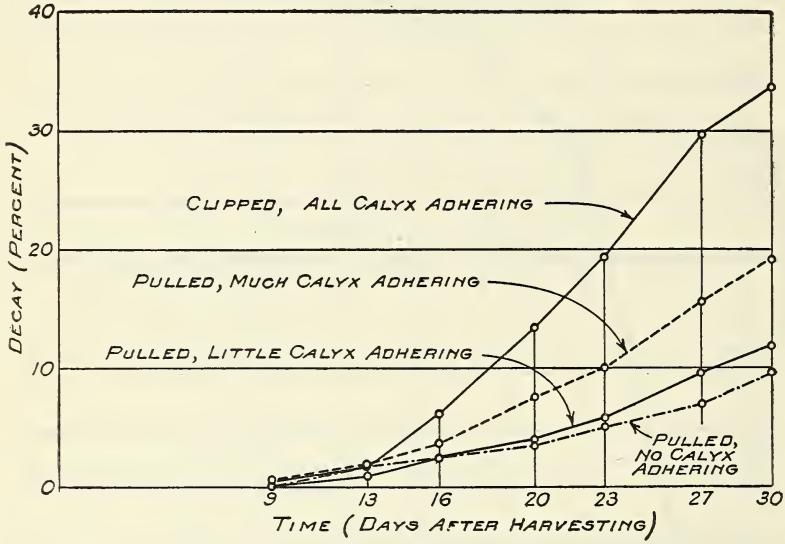

FIGURE 5.—Average decay of grapefruit harvested by clipping or by pulling, with various amounts of calyxes adhering, and held at 70° F. during the season of 1934–35.

omitted. It will be observed (fig. 5) that the keeping quality of this grapefruit was influenced considerably by the amount of stem parts adhering. The fruit with little or no stem parts adhering decayed less rapidly than that with all or considerable stem parts remaining.

Figure 6 shows the keeping quality of more mature Marsh grapefruit than that considered in figure 5. The fruit was picked March 21, 1934, washed and packed in the usual commercial way, stored at 50° F. for 30 days, and then transferred to a 70° room. These data are the combined records of first- and second-grade fruit which was not given the ethylene treatment, but one-half was treated with borax on arrival at the packing house. In addition all lots were treated in the usual way with borax during the washing and packing operation the day after picking. Of course there was more decay in the fruit that received only the delayed application of borax. These results with riper fruit also show that pulled fruit with the calyx adhering to it kept about as well as clipped fruit.

Pulled fruit with only the stem cushions adhering likewise kept about as well as that with stem parts completely removed. It is apparent, therefore, that the reduction in stem-end rot in pulled fruit is influenced considerably by the amount of stem parts left on the fruit, and that the calyx may be an important avenue of entrance for the stem-end rot fungi.

POSSIBLE OBJECTIONS TO PULLING GRAPEFRUIT

Pulling grapefruit is a much quicker and cheaper method than clipping, but these two possible objections against it may be raised: (1) It may increase blue mold rot to such an extent that total decay from all causes will be greatly increased, and (2) the trade will not accept pulled fruit because it would be regarded as wind-

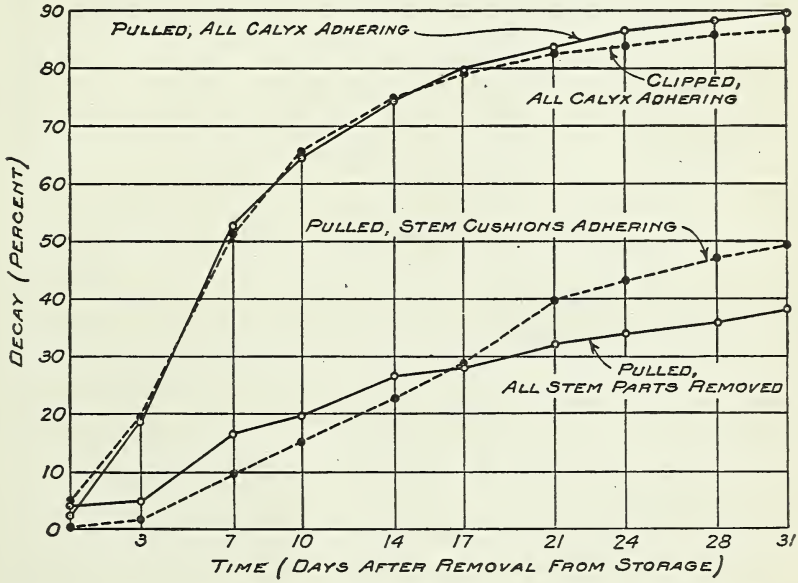

FIGURE 6.—Average decay of grapefruit harvested by clipping or by pulling, with various amounts of stem parts and calyxes adhering, and stored 30 days at 50° F. and then held at 70° during the season of 1933–34.

falls. Experience has failed to show that either of these objections is important. In none of the tests has blue mold been an important factor, and in but few has it been as great in pulled fruit as in clipped fruit, even when the borax treatment was omitted. No complaints have been received regarding trade resistance to pulled fruit. This method of harvesting grapefruit has been in use commercially for two seasons, and a sufficient number of shipments have been made to prove that pulled grapefruit is readily accepted by the trade. It would seem that in time the trade may demand the use of this method because of the better keeping quality of grapefruit so harvested, and that the industry will favor it also, not only for this reason but also because it is a cheaper method.

SUMMARY

Pulled grapefruit, except when very ripe, is less rapidly affected by stem-end rot than is clipped grapefruit. When fruit is very ripe, the results from pulling and clipping are the same, so far as decay is concerned.

Borax treatment given when the fruit is received at the packing house is very effective in further reducing decay from stem-end rot as well as from blue mold. A timely application of borax should be regarded as a part of the harvesting process.

Pulling is especially recommended for fruit intended for storage or for the export trade.

The trade has readily accepted pulled grapefruit.

Pulling grapefruit is cheaper than clipping.

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